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ABSTRACT

The effects of cognitive and behavioral orienting activities and practice on student learning of cued and uncued information were examined in this study. The subjects were 54 grade 9 students (28 males and 26 females), who were classified as high or low ability based on the verbal intelligence estimate of the Iowa Test of Basic Skills. These students received a computer-based lesson on the voyages and discoveries of spacecrafts, including either a cognitive or behavioral orienting activity, and a 28-item posttest was used to measure recall. Fourteen posttest questions were cued via the orienting activity; the remaining 14 questions were not cued. Half of the cued and non-cued items were practiced using parallel items during the lesson. A significant difference was found between practiced and non-practiced items, cued and non-cued items, and high and low ability students. Significant interactions were found between orienting activity and cuing, orienting activity and practice, and orienting activity by cuing by practice. Practice emerged as the most powerful design component. Directions for further research are identified, and 30 references are listed. Several sample cognitive and behavioral orienting activities are appended. (MES)

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The Role of Practice Versus Cueing During Computer-Based Instruction

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ABSTRACT

The purpose of this research was to study the effects of cognitive and behavioral orienting activities and practice on student learning of cued and uncued information. The subjects were 54 ninth grade students: 28 males and 26 females. The instructional content for the study was based on the voyages and discoveries of spacecrafts. A significant difference was found between practiced versus non-practiced items, high versus low ability students, and for cued versus non-cued items. In addition, significant interactions were found between orienting activities and cueing, orienting activity and practice, and orienting activity-by-cueing-by-practice.

The Role of Practice Versus Cueing During Computer-Based Instruction

The importance of practice during instruction has been emphasized by several researchers. Whereas practice per se appears to be of little inherent value (see, for example, Gagne', 1962; Dressel, Schmid & Kincaid, 1952), practice based upon explicit or general relationships with intended learning provides important support for learning. The early work of Thorndike (1931, 1932), for example, equated practice with reinforcement, suggesting that learning is systematically shaped through practice. For different reasons, contemporary cognitive theorists also support the value of practice during instruction. Both Anderson (1980) and Mayer (1978) have developed cognitive models which support the role of practice in reducing inhibition, improving responsiveness to related instruction, and enhancing retention.

The incorporation of pre-instructional orienting activities designed to heighten receptiveness to subsequent instruction has also been advocated (Hannafin & Hughes, 1986) . Advance organizers, a variation of cognitive orienting activity, are thought to provide cognitive anchoring mechanisms through which individuals assimilate instruction (Ausubel, 1979; Mayer, 1978), focus attention selectives (Derry, 1984), and alter the manner in which information is processed (Spiro, 1980). Explicit behavioral orienting activities are believed to aid intended learning of cued content but to the limit learning of incidental, uncued information (Duchastel & Brown, 1974; Kaplan & Simmons, 1974; Reynolds & Anderson, 1980). Activities that are integrative, requires greater integration of new with existing knowledge, often facilitate the learning of both cued and uncued lesson information (Glover, Bruning & Plake, 1982; Glover, Plake & Zimmer, 1983; Klauer, 1984). Whereas the effects of orienting activities in isolation have been supported (e.g., Mayer, 1979, 1984) contradictory findings have also been reported--particularly when the activities are employed in the presence of more powerful instructional variables (Barnes & Clawson, 1975; Hannafin, Phillips, Rieber & Garhart, 1986).

Whereas some design strategies may be effective when employed in isolation, their effects are often subsumed by other powerful techniques. Rarely have multiple instructional strategies been combined in an attempt to measure their relative value in a comprehensive instructional system. The purpose of this study was to examine the effects of orienting activities and practice on the learning of cued and uncued information presented via computer-based instruction. Main effects were predicted for orienting activities, cueing, and practice. Interactions, moderated principally by the enhanced power of practice, were also predicted.

METHODS

Subjects

The subjects were of 54 ninth grade students: 28 males and 26 females. All students were volunteers but were representative of typical ninth graders.

Materials

Instructional content. Instructional content was designed to be motivational, but unfamiliar to students. The lesson was based on material published by the National Aeronautics and Space Administration (1981) dealing with the Pioneer and Explorer spacecrafts that the outer reaches of the solar system. Technical material was reworded or clarified to be understood by typical ninth grade students.

The instruction was divided into six sections. Each section was devoted to a different aspect of spaceflight, and was introduced by related graphics in order to maintain student interest.

The instructional sequence began with a computer graphic depicting a spaceship launch. The next frame included an orienting activity which contained two cues related to the subsequent instructional segment. The cues were stated using either specific behavioral or integrative cognitive terms. An example of a behavioral and the corresponding cognitive orienting activity is shown in Figure 1.

INSERT FIGURE 1 ABOUT HERE

The average number of instructional frames per section was five, with individual sections consisting of four to seven frames.

Practice questions were then embedded at the conclusion of each section. The information related to one of the practice questions was cued initially by one of the orienting activities; the content of the other question was not cued during by the orienting activity. The questions were in multiple choice format, and contained one correct answer and three distractors. Upon entering the answer the student received immediate feedback either confirming a correct response or providing a correcting sentence informing the learner of the correct answer. The lesson was not repeated. Feedback back was only given related to the practice question. The amount of instruction was identical for all students.

The design of the lesson was based upon the software design model of Gagne', Wager, and Rojas (1981). Frame protocol was consistent so that a familiar computer displays were available during the instruction. All text was double spaced and the instructional material was broken into thematically related sections, separated by transitional graphic frames, to smooth the flow of the lesson and to minimize abrupt shifts in procedures.

Dependent Measures

A 28-item posttest related to the instruction was used to measure recall. Fourteen posttest questions were cued via the orienting activity; the other 14 questions were not cued. Seven of the cued items were practiced using parallel items during the lesson; the remaining cued items were not practiced. Of the 14 lesson items that were not cued, seven were practiced using parallel items during the lesson and seven were not practiced. This breakdown resulted in recall scores for four dependent measures: Cued and Practiced, Cued and Not Practiced, Not Cued but Practiced, and Not Cued and Not Practiced. The split-half reliability coefficient for the 28-item multiple choice posttest was .66.

Design

The study employed a completely crossed 2 x 2 between subjects design, with two additional factors crossed within subjects. The between-subjects experimental treatments included orienting activity (Behavioral, Cognitive) and ability (HI, LO). Students were classified as HI or LO in ability based on a median split of verbal intelligence estimate on the Iowa Test of Basic Skills (ITBS). The within-subjects factors included two levels of content cueing (Cued, Not Cued) and two levels of practice (Practiced, Not Practiced).

Procedures

Students were randomly assigned to an orienting activity group. At the outset of the lesson students were advised to study lesson frames carefully and were instructed in the procedural operation of both the lesson and computer. The students were also told that help could not be provided during the lesson except to pronounce unfamiliar words. During the lesson, student responses were stored for subsequent analysis.

Upon completion of the lesson, the posttest was administered immediately. The test was presented via computer, but no response feedback was provided. Again, student responses were evaluated for correctness and stored for subsequent analysis. Students were then instructed to signal the investigator that the lesson had been completed.

RESULTS

The means and standard deviations for each dependent measure are included in Table 1. The MANOVA source data are contained in Table 2.

INSERT TABLES 1 and 2 ABOUT HERE

Main Effects

Practice. A highly significant difference was found between the overall mean scores on practiced versus non-practiced information, $F(1,50) = 234.62$, p .0001. Practiced information was recalled at a much higher rate (mean = 12.79) than non-practiced information (mean = 8.69). Practice alone accounted for roughly 79% of the variance-accounted-for by treatments.

Cueing. A significant difference was detected between the overall mean scores for cued versus non-cued items $F(1,50) = 12.82$, p .005. More cued items were recalled (mean = 11.16) than non-cued items (mean = 10.22). Cueing accounted for approximately 4% of the sure variance.

Ability. As expected, a significant difference was also found between the overall mean scores obtained by Hi versus Lo students, $F(1,50) = 9.36$, p .005. High ability students recalled more factual information (mean = 22.84) than low ability students (mean = 20.13). Ability accounted for roughly 7% of the controlled sure variance.

Interactions

Orienting Activity by Cueing. A significant interaction was found between orienting activity and cueing, $F(1,50) = 9.26$, p .005. This interaction is illustrated in Figure 2. Cueing was most effective for the behavioral orienting activity while the remaining mean scores were comparable. The interaction accounted for roughly 3% of the overall treatment effects.

INSERT FIGURE 2 ABOUT HERE

Orienting Activity by Practice. A significant interaction was found between orienting activity and practice, $F(1,50) = 8.18$, $p < .01$. This interaction is illustrated in Figure 3. Practice improved scores for both the behavioral and cognitive orienting strategy, but proportionately more for the cognitive strategy. Roughly 3% of the controlled variance was accounted for by this interaction.

Orienting Activity-by-Cueing-by-Practice. A significant three-way interaction illustrated in Figure 4, was also found. However, the magnitude of this effect was modest in comparative terms, $F(1,50) = 4.36$, $p < .05$. This effect accounted for only 1% of the treatment variance. Both cueing and practice demonstrated an influence on the performance of the behavioral orienting activity group, but not the cognitive orienting activity group.

Overall, the design variables used in this study accounted for roughly 54% of the overall score variance. No other main effects or interactions were statistically significant.

INSERT FIGURE 3 AND FIGURE 4 ABOUT HERE

Discussion

The purpose of this study was to examine the effects of orienting activities and practice on the learning of cued and uncued information during computer-based instruction. The major findings indicated that practice was a significant component in isolation as well as in combination with other design variables.

Practice was by far the most powerful design component in the study. As a main effect, practice alone accounted for more than 79% of the observed score variance among the treatments. In a comparative sense, practice was far more powerful than the other design components used in this study, including both orienting activity and cueing. This is consistent with researchers who have advocated the inclusion of criterion-based practiced during instruction (Ausubel, 1978; Keller, 1982; Mayer, 1984). Practice appears to make explicit the intent of the lesson, providing the learner with an unambiguous aid for remembering. Practice also seems likely to strengthen relationships among practiced concepts, as well as practiced information with prior knowledge (Salisbury, Richard, & Klein, 1986).

Evidence for the power of practice was also reflected through the interaction between practice and orienting activity. The effect of practice was somewhat more effective the explicit behavioral than the more assimilative cognitive, orienting activities. This is evident in the uniform effect for practice across both orienting activities, but the superior performance of the behavioral group in the absence of practice. In effect, practice subsumed the effects attributable to the explicit orienting activity, and equalized the performance of both groups unspecified of orienting activity.

In the absence of practice, learning was more efficiently directed through the use of factually specific orienting devices than more abstract techniques. As students progressed through the lesson, they likely confirmed the relevance of the strategy, became more inclined to use the strategies provided, and built stronger associations among the activity provided, the factual nature of practice sessions (based on information that was practiced), and the eventual recall test. In effect, practice was important for both behavioral and cognitive groups, but most important for the cognitive orienting activity group.

Nearly 83% of the treatment score variation was accounted for by the combination of practice cnd practice-moderated interactions. This finding suggests that while other design features may result in statistically reliable effects, such effects either pale in the presence, or are enhanced differentially as a function, of practice. In this study, for example, the combination of practice and orienting activity yielded a significant interaction, while orienting activity alone was not a significant instructional component. Given the preponderance of earlier evidence suggesting significant effects for orienting activities such as advance organizers and behavioral objectives (e.g., Hamilton, 1985; Mayer, 1984; Melton, 1978), orienting activity effects might have been predicted in this study as well. However, when instructional components are combined into the integrated systems of typical computer-based instruction, the effects of such activities are often subsumed (Hannafin & Streisel, 1986). In effect, while orienting activities seem likely to exert influence in less powerful or poorly organized lessons (Mayer, 1979), they are less likely to be needed as the instruction is supported in a comprehensive lesson containing varied but powerful features such as practice.

A significant effect was also found for cueing as well as the cueing-by-orienting activity interaction. In general, cued items were recalled at a higher rate than uncued items. Most of this difference, however, was attributed to the influence of the behavioral activity on information cued through the strategy. The behavioral activity yielded the best performance for cued information; each of the remaining combinations yielded comparable performance. This is consistent with findings related to the relationship between orienting activity and practice (Koran & Koran, 1975; Melton, 1978; Reynolds & Anderson, 1982) which predicts most effective performance for information explicitly cued.

The cognitive activity, however, neither cued to specific criterion elements nor provided support to related lesson elements not cued. This is inconsistent with research where integrative activities were found to support the learning of both intended and incidental information (Klauer, 1984; Glover, Plake & Zimmer, 1983). In effect, a preparatory set was instilled via the cognitive activity which neither predisposed learners to particular lesson detail nor improved the learning of incidental information. Specific behavioral strategies, on the other hand, were most effective for the recall of strategy-specific (intended) learning but provided little support for learning strategy-irrelevant (incidental) lesson information.

The modest interaction among practice, orienting activity, and cueing suggests that practice and cueing are most influential under behavioral, and least influential for cognitive, orienting activities. The effects of practice and cueing were incremental for the behavioral orienting activity: Practice and cueing were most effective, followed by practice without cueing, cueing without practice, and no cueing and no practice. Neither practice nor cueing, however, were of significant impact for the cognitive orienting activity group. These results tentatively suggest that, for verbal information, behavioral strategies designed to focus explicitly on intended learning tend to yield the best outcomes when paired with relevant cueing and practice.

Several directions for further research are indicated. Cognitive orienting activities may be more important for higher-level learning than the verbal information assessed in the present study. To the extent that broader contextual learning is required, such as inferential or problem-solving learning, cognitive orienting activities are likely to be effective (Hannafin & Hughes, 1986). The effects of practice as a post-organizer of lesson information may not be as isolated for higher-level learning as for the learning of facts. Research designed to compare orienting activity effects across levels of learning will better define the generalizability of the present findings.

If, as proponents suggest, abstract orienting activities better enable learners to form relationships among lesson concepts as well as with prior knowledge (Ausubel, 1978; Mayer, 1984), practice might need to be examined as a between-subjects variable rather than as the within-subjects variable employed in this study. Practice seems likely to generalize when the nature of the practice is integrative in nature, such as required for higher-level learning. If so, "spread of activation" (Gagne, 1985) resulting from practice needs to be controlled between subjects.

Possible long-term retention differences resulting from the instructional manipulations used in this study, as well as the subsequent acquisition of related information, also require careful examination. Orienting activities that encourage greater depth of processing during encoding might be expected to yield greater retention of knowledge than those that do not. Efforts to establish the impact of orienting and processing activities in a more comprehensive framework should be advanced.

The present study confirmed the power of practice in the learning of verbal information, and supported the interactive effects among orienting activities, cueing, and practice. Whereas practice may exert a dominant influence among the lesson design components in the present study, it seems reasonable that more complex relationships among practice and related design variables will be identified. Future efforts to establish the effects of the various components of integrated CBI systems should prove valuable in prescribing a more comprehensive technology of lesson design.

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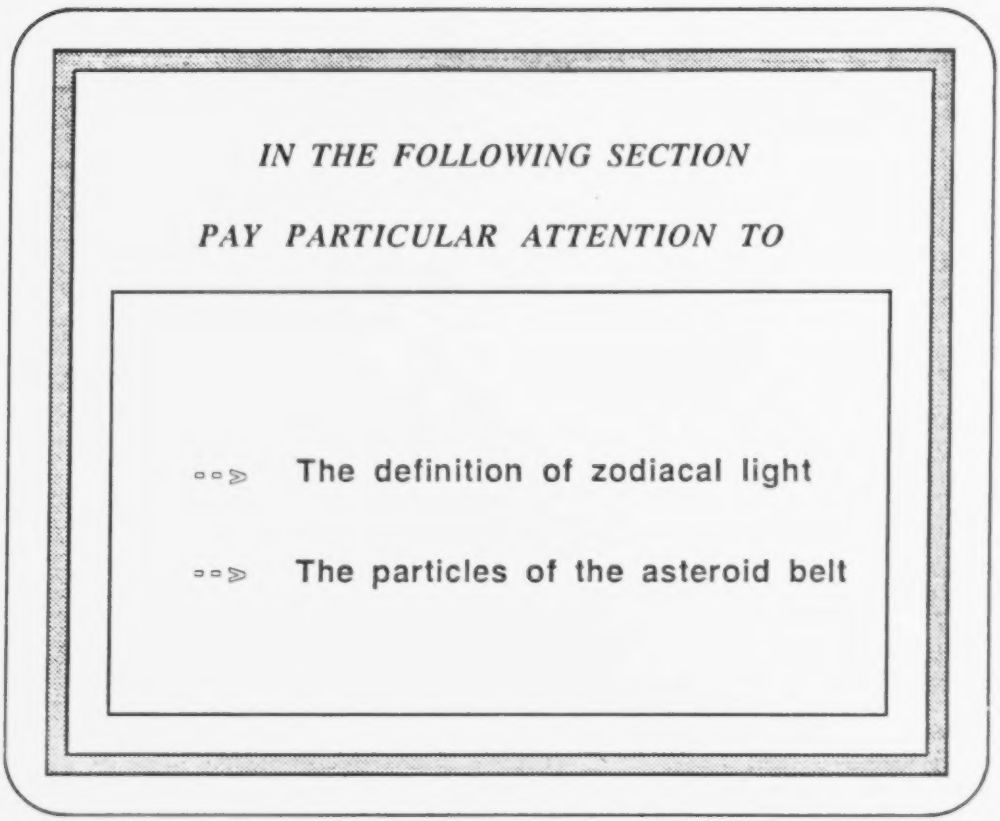
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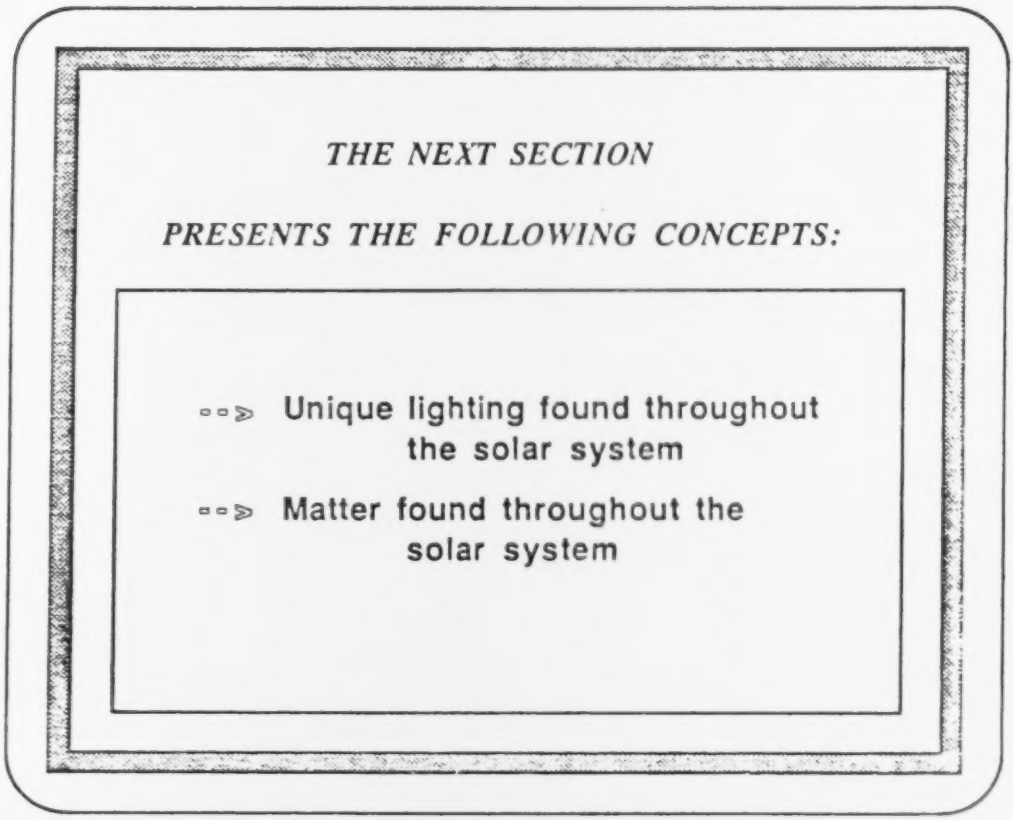
Figure 1. Sample Behavior and Cognitive Activities. (1 of 2)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Matter found throughout the solar system

Figure1: Sample Behavioral and Cognitive Activities. (2 of 2)

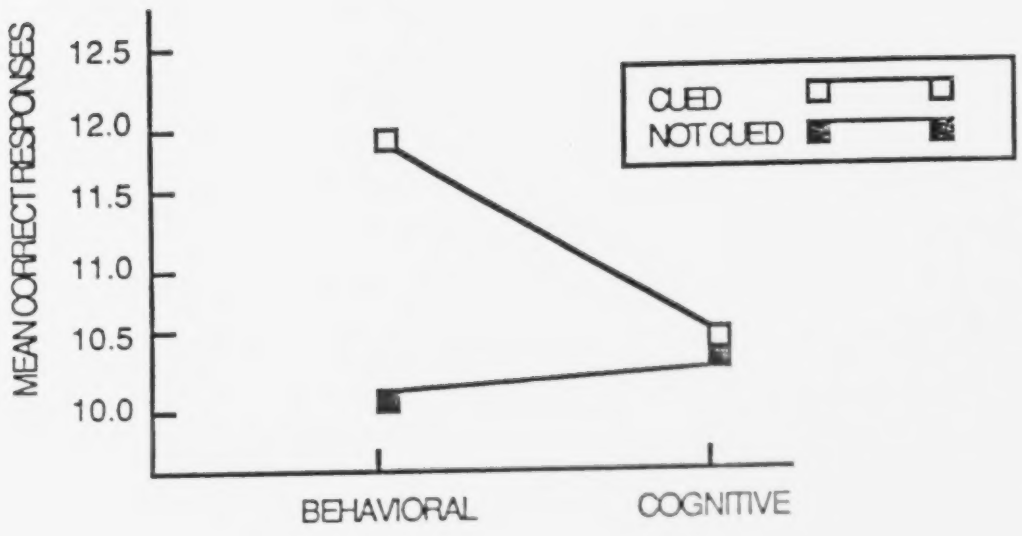

Figure 2. Interaction Between Orienting Activity and Cueing.

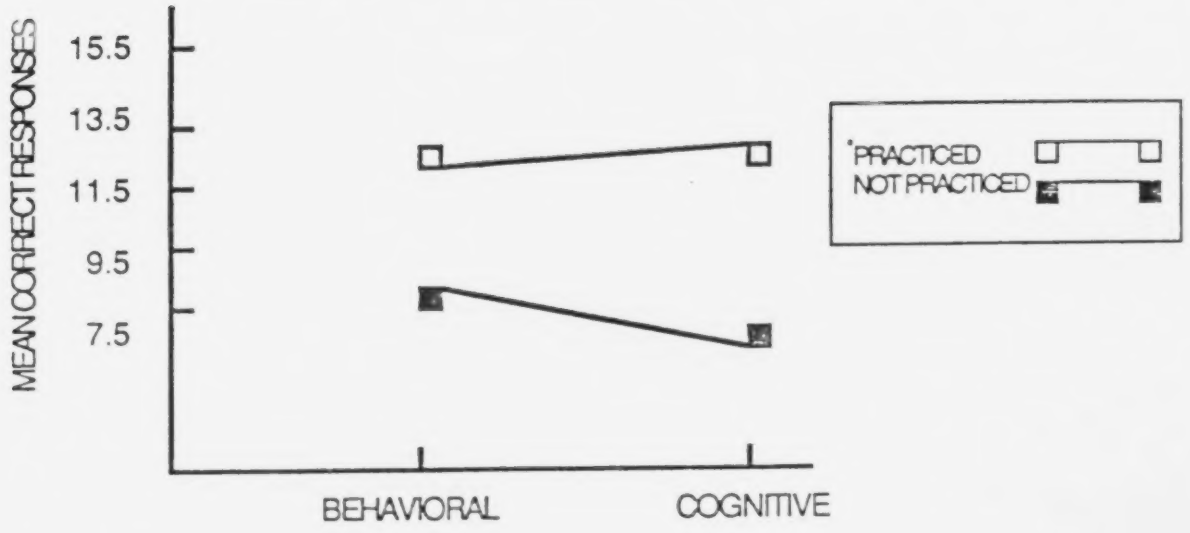

Figure 3. Interaction Between Orienting Activity and Practice.

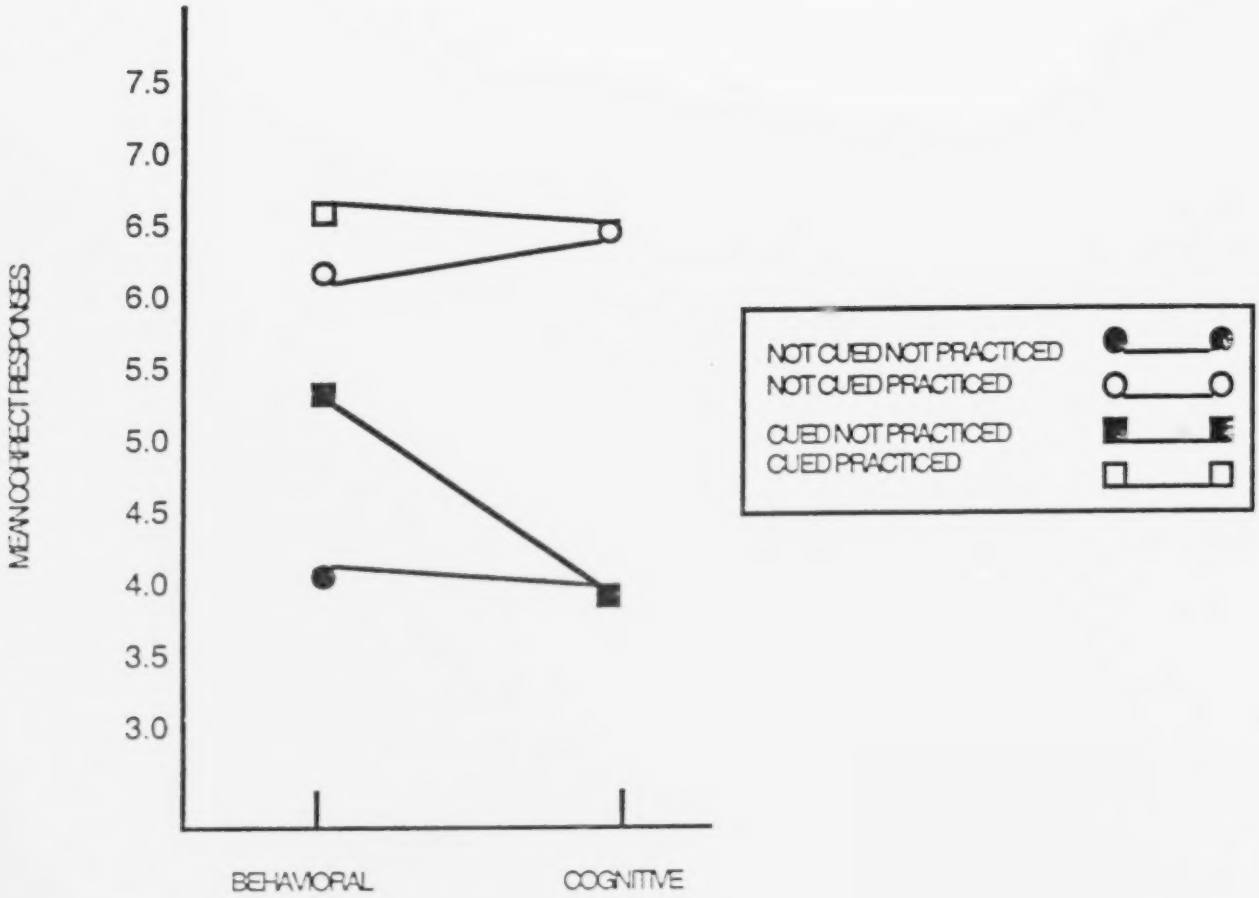

Figure 4. Interaction Among Orienting Activity, Cueing, and Practice.